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CROW-WATERFOWL  
RELATIONSHIPS

BASED ON PRELIMINARY STUDIES ON  
CANADIAN BREEDING  
GROUNDS

By

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Division of Wildlife Research  
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By E. R. KALMBACH, *senior biologist, Section of Food Habits, Division of Wildlife Research, Bureau of Biological Survey*

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### INTRODUCTION

With the object of obtaining a current insight into the relationship of crows to waterfowl on their breeding grounds, a study was inaugurated in the spring of 1934 and continued through the nesting season of that and the following year. As originally planned, it called for field studies both in Canada and in the northern United States, but drought conditions had so drastically reduced the breeding population of ducks within our borders by the spring of 1934 that, after a futile effort to locate suitable areas in this country, plans were changed and the studies were restricted to Canadian areas in Saskatchewan and Alberta, where ducks and crows could be found in reasonable abundance and in close association.<sup>1</sup>

The scenes of the studies cover three rather circumscribed areas—two in Saskatchewan and one in Alberta—and, although the writer believes that the facts revealed and the conclusions reached are reasonably accurate for these areas, no claim is made that the findings

<sup>1</sup> Grateful acknowledgment is made to both Dominion and Provincial officials in Canada, through whose kind cooperation in the granting of permits and the loan of equipment the work was facilitated; to O. C. Furniss, of Prince Albert, Saskatchewan, for volunteered services in the study of nests at Waterhen Lake, Saskatchewan, and in the section about Prince Albert, both in 1934 and 1935; and also to C. S. Williams, of the Biological Survey, who accompanied the writer in 1935, and gave untiring devotion to the field studies, rendered aid in tabulating and computing the results, and, with S. E. Aldous, also of the Biological Survey, assisted in the examination of stomachs of crows collected.



represent a cross-section of crow-waterfowl relationships throughout Canada. As a matter of fact the results obtained in the two areas in Saskatchewan clearly show that there may be great variation in the degree of pressure exerted by the crow at points only 50 miles apart. Much less can the results be construed as representative of what takes place in the Northern States of this country, where as yet there is a lack of adequate information regarding "average" conditions on duck-nesting grounds.

By reason of the character of the nesting environment found and the observed density of the crow population, the areas at Waterhen Lake, Saskatchewan, and the lake region to the southeast of Edmonton, Alberta, presented conditions highly conducive to crow attack upon nesting ducks; in the pot-hole region about Prince Albert, Saskatchewan, the relationship was much less acute.

#### AREAS STUDIED

##### WATERHEN LAKE, SASKATCHEWAN, AND VICINITY

[May 21-July 10, 1934; June 8-July 21, 1935]

Waterhen Lake, about 35 miles on an air line to the southeast of Prince Albert, Saskatchewan, was the scene of most of the nest-history studies in 1934 (pl. 1, A). This lake, lying just south of latitude 53° north and not far from the meridian (105° west) that passes through Denver, Colo., formerly was one of the outstanding nesting and feeding areas of ducks in southern Saskatchewan. More than a decade ago it was drained in an attempt to convert its 10 or more square miles of water surface into agricultural land. This effort failed, however, and in the fall of 1932 the outlet of the drainage system was closed and the waters of the inflowing Carrot River allowed to accumulate. By the summer of 1934 the run-off of two winters had reflooded Waterhen Lake to a depth of about 4 feet at its deeper points, and much of the original marsh environment had been restored. Through the center of this expansive area were the two parallel banks of the canal used to drain the area. These furnished an ample dry nesting habitat for waterfowl. With its water level nearly constant throughout the summer of 1934, Waterhen Lake became the center of attraction for breeding ducks in the section southeast of Prince Albert, and 192 of the 211 nests whose histories were completed during that season were situated on the two canal banks.

In several respects the environment at Waterhen Lake, particularly with respect to the vulnerability of duck nests to attack by crows, deviated from what might be considered normal. Here the ducks could find on the two canal banks high land suitable for nesting sites in the center of a large expanse of marsh. During May and early in June the available cover on these dikes consisted of the dead vegetation of the previous year, largely *Fluminea* and *Carex*, with here and there a few sparse clumps of willow. There was little intrusion by human beings on the dikes other than that of the investigators. The location of nests on the long parallel dikes, however, separated as they were by half a mile to 2 miles from other dry land, had a distinct bearing on their exposure to attack by agencies other than man.

In the first place, it may be explained that crows, which nested abundantly in woodland areas surrounding Waterhen Lake, make a regular practice of flying out to the canal and following the banks, manifestly in search of duck nests. Such performances were observed frequently, and, despite the persecution to which they were subjected by red-winged and yellow-headed blackbirds, the crows persisted in making these forays. The location of this group of nests in a more or less direct line doubtless afforded better chances for discovery by crows than if they had been located irregularly along the meandering border of some marsh or lake shore.

The canal banks also presented a condition somewhat peculiar with respect to small mammalian predators or egg destroyers. Owing to the isolation of the area, such common disturbing elements as domestic livestock, dogs, and feral cats did not enter the picture, but at the ends of the dikes the nests were accessible to skunks. Throughout the entire length of the dikes muskrats were common, although in no instance could depredations on eggs be definitely ascribed to these rodents. The work of weasels and minks came to light at several of the nests. Red-tailed and marsh hawks were present, and evidence of their attack on birds was found, but in no case did it appear to be associated with any of the birds whose nests were under observation.

The outer border of Waterhen Lake presented an environment typical of the edge of any expansive marsh, and the nests located there in 1934 were exposed to attack or disturbance not only by crows but by various small mammals, including roaming dogs, and, on higher land, by ground squirrels. In 1935 all the 42 nests under observation at this lake were on the canal banks and subject to essentially the same hazards that existed there in the previous year.

Twenty-one additional nests under observation in the vicinity in 1934, situated at a number of small lakes, sloughs, and pot holes, were all within easy reach of crows and such other disturbing factors as dogs and livestock.

##### POT-HOLE COUNTRY NEAR PRINCE ALBERT, SASKATCHEWAN

[May 21-July 10, 1934; May 3-July 22, 1935]

Four of the nests recorded in 1934 and 77 of those observed in 1935 were in the pot-hole and small-slough country in the vicinity of Prince Albert, Saskatchewan, and were reported upon by O. C. Furniss of that place. This district, located on the divide between the Transition and Canadian Life Zones, has an undulating surface, with bodies of water that range in size from less than an acre up to 10 or 12 acres. These usually are margined with a healthy stand of *Fluminea*, *Panicularia*, *Carex*, and clumps of *Scirpus* and *Typha*. The surrounding arboreal growth consists mainly of willow and aspen.

Agricultural activities surround and often reach down to the very borders of the pot holes and, as a result, nesting ducks may be exposed to disturbance by grazing livestock, interference by man, and even fire. Although crows appeared to be the outstanding wildlife factor affecting the welfare of duck nests in this vicinity, their relative scarcity there, compared with the other areas studied, made their influence of much less consequence.



## COOKING LAKE DISTRICT, SOUTHEAST OF EDMONTON, ALBERTA

[May 19-July 26, 1935]

An area to the southeast of Edmonton, which for convenience may be referred to as the Cooking Lake district, was chosen for the studies of 1935, not only that information might be available from the Province of Alberta but also that it might serve as a check against results obtained under the somewhat peculiar conditions prevailing on the canal banks at Waterhen Lake, in the adjoining Province. Although some nests studied were on the shores and bays of Cooking Lake itself, by far the greater number were on the islands and shores of other bodies of water in the vicinity, notably Ministik, Hastings, and Big Island Lakes. About three-fourths (167) of the nests of which the histories were completed in 1935 were located on islands in these three lakes; the others were in shore-line marshes, sloughs, or hay fields, or in the "bush." These islands, ranging in size from less than an acre to as much as 15 acres, usually supported in their centers a stand of spruce surrounded by a fringe of poplar, birch, and willow.

Spruces, where present, furnished ideal nesting sites for crows, and at Ministik Lake in particular, one or two nests of crows were to be found on each of the principal islands (pl. 1, *B*). With nesting crows in the center, the ducks making use of the shore line were continually in jeopardy. A crow could not leave its nesting site without passing over an actual or potential duck-nesting area. Even on the islands at Hastings Lake, which supported no stands of spruce, crows were accustomed to make regular trips of half a mile or a mile from the mainland in search of duck eggs.

In other respects, however, the island environment was favorable to nesting ducks, particularly since there was an absence of farm operations, grazing livestock (pl. 2, *A*), wandering dogs, and, to a marked extent, intruding human beings. Evidence of skunks was infrequent on even the larger islands, and on the smaller ones, devoid of arboreal vegetation, it was apparent that mammalian pressure on the duck population was practically nil.

Early in the season the dead growth of the previous year's stand of round bulrush (*Scirpus validus*) and numerous grasses furnished the main nesting cover (pl. 2, *B*). In the district as a whole, there was ample cover of this kind for many times the duck population present. Later in the season the new growth, including dense stands of thistle on some islands, created a cover from which even the ducks had difficulty in freeing themselves when flushed.

## METHODS OF APPROACH

Inasmuch as the object of this study was to disclose the hazards encountered by waterfowl on their breeding grounds and to estimate the losses experienced in their nesting attempts, main reliance was of necessity placed on the field observational method of approach. Despite certain limitations, this procedure yielded convincing information on the effect of predator feeding habits and other suppressive agencies. It also permitted a direct and understandable expression of such an appraisal, which would have been obtainable through no other means. To supplement these field studies, however, and to

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PLATE 1



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## DIKE AND ISLAND DUCK-NESTING ENVIRONMENTS.

*A*, The dikes of a canal traversing Waterhen Lake, Alberta, Canada, the site of a former reclamation project that has reverted to the wild, afforded excellent nesting sites. The concentration of ducks on these dikes, however, induced crows to search the area regularly for eggs. *B*, On islands in Ministik Lake, Alberta, crows often used the spruces and ducks, the shore-line cover, as nesting sites, which meant that the duck nests were constantly in jeopardy, as the crows could not travel to or from their nests without crossing the duck-nesting area.





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A, Wild-fowl production and intensive agriculture often do not harmonize. The mainland shore, heavily pastured, held no attraction for nesting ducks, which availed themselves of the relative security afforded by an island environment (shown in foreground) to which the cattle did not have access. Ministik Lake, Alberta, Canada. B, Despite this excellent cover that completely hid a mallard's nest from view, crows located and destroyed the eggs. The ladder, which had been washed ashore, may have aided the marauders by affording a convenient means of approach. South Cooking Lake, Alberta.

allow comparisons with other similar material collected in this country, a moderate number of stomachs of crows were collected and subsequently examined, and the results are reported upon in this circular. In the field studies, attempt was made to obtain the completed histories of an adequate and representative series of duck nests. This was carried out in a manner aimed to disturb the nesting birds as little as possible and to give thereby no marked advantage to predators.

#### TECHNIQUE EMPLOYED IN OBSERVATION

Most of the nests were located by methodical search of favorable habitats. They were considered eligible for record upon the laying of the first egg, and studies were terminated when the eggs were hatched, destroyed by outside agencies, or definitely abandoned by the birds. Serial numbers were assigned to them in the order in which found, record being kept in a loose-leaf notebook, one page to the nest. This permitted the addition of data on new nests and the removal of data for nests when their histories were completed. By making successive trips over the several areas in the same or in the reverse order, locating the nests was facilitated.

When a nesting bird was flushed (which was the usual manner in which a nest was disclosed), the vegetation in the vicinity was disturbed as little as possible. Note was taken of the exact location of nest, the species, number of eggs, degree of concealment, character of cover, quantity of down present, proximity and abundance of crows or other possible predators, and any other factors that might have a bearing on the future history or fate of the nest. The nest was then "flagged" by means of a small numbered card, which was either fastened to vegetation so as not to flap in the wind or else placed under rocks, usually about 10 to 50 feet away. Search for new nests and visits to those previously located were stopped whenever crows were nearby, and work was resumed only after they had left the vicinity.

Frequency of visits to the nests varied somewhat with the exigencies of the work. At Waterhen Lake, in 1934, the intervals between visits ranged from 4 days to a week, and in 1935 a period of a week usually was allowed to elapse between visits. With such an interval, the number of visits needed to complete nest histories was reduced. Of the 224 nests under observation in 1935, studies of 86 were terminated at the time of the first visit after their discovery; 45 on the second trip; 47 on the third; 37 on the fourth, and in 9 instances 5 visits had to be made before the history had been completed.

#### IMPORTANCE OF ACCURATE DIAGNOSIS

Next in importance to the need of extreme care in making nest observations is the necessity of correctly reading signs at destroyed nests. Although some of the evidence is difficult to interpret, the work of the crow often is characteristic and plainly evident.

In attacking a nest crows ordinarily destroy the whole clutch of eggs; sometimes, however, they will get their fill short of destruction of the entire set or will leave if the female duck returns to protect and incubate the eggs left. Actual egg eating may take place at or near the nest, or, after having been pecked into, the eggs may be



taken to some bare spot or favorite stump or boulder and there devoured. When the latter procedure is employed, one may find crow-pilfered duck nests with no trace of the shell or contents in the nest, but the telltale evidence may be found at a feeding spot nearby. In preying on eggs that have not been incubated, crows will peck or bite a hole in the shell sufficiently large for them to drink or gobble down the contents. Observations have demonstrated that in making even a small opening into the egg, part of the shell is almost invariably eaten and, when larger apertures are made, much of the shell may be swallowed. It is for this reason that instances of egg eating by crows seldom escape detection in the course of stomach examination.

Throughout these studies care was taken not to charge either the crow or other predators with duck-egg destruction unless the evidence was convincing. Empty nests were not interpreted as cases of crow vandalism unless freshly broken shells of eggs of the species concerned, pecked in characteristic crow fashion, were found nearby. This procedure was adopted despite the fact that snakes large enough to remove duck eggs, if present at all, were not common in the areas studied and therefore had to be ruled out of the picture. Similar conservatism governed decisions with respect to other predators. Whenever a reasonable doubt existed regarding the cause of the destruction of a nest it was considered unknown.

#### POSSIBLE HARM FROM INTRUSION OF OBSERVERS

The nest-history method of approach to studies of this kind has been criticized on the ground that repeated visits of the observer may show predators the way to nests or otherwise reveal their location. Likewise it has been asserted that desertions by the female may be unwittingly increased thereby. The weight of such criticism was recognized from the very beginning of these studies, and every effort was made to keep such disrupting factors at a minimum.

In his appraisal of nest-history studies of the bobwhite in the Southern States, Stoddard<sup>2</sup> came to the conclusion that, in thickly settled country where there was a profusion of trails and tracks made both by human beings and by domestic animals, predators have little to gain by following them with the hope of finding food. He learned also that the percentage of successful hatching was even higher in the group of nests visited repeatedly than in those the history of which had been terminated when first discovered. Stoddard admitted, however, that in unsettled country human tracks might be such a novelty that trailing by predators would lead to increased nest destruction.

Errington,<sup>3</sup> in his suggestions for nest studies in Iowa, while stressing the need of care in making field appraisals of nest misfortunes and admitting the difficulties that arise, looks upon the acquisition of nesting data on hundreds of nests as one of the most practical ways to determine factors governing the welfare of nesting game birds.

<sup>2</sup> STODDARD, H. L. THE BOBWHITE QUAIL: ITS HABITS, PRESERVATION, AND INCREASE. 551 pp., illus. New York. 1931.

<sup>3</sup> ERRINGTON, P. L. SUGGESTIONS AS TO NESTING STUDIES OF IOWA GAME BIRDS. Iowa Bird Life 2: 46-48. 1932.

In analyzing the data accumulated in these studies certain facts were revealed with respect to the degree of interference caused by the intrusion of the observer. One of these concerns the extent of desertion observed, an element that might be construed as an index to any disruption caused by an observer's presence. Of the 512 nests for which histories were completed, 40 or slightly less than 8 percent, were recorded as failures due to desertion (p. 18). In some of these instances it could be demonstrated that the female had returned subsequent to the last previous visit of the observer. In such cases desertion was attributed to "natural causes" and not to interference by the observer. On the other hand, it is likely that some of the nest destruction charged to crows may, in fact, have been cases of desertion due to intrusion by the observer, followed, in turn, by the work of this ever-alert predator, to which a clutch of abandoned eggs, if not actually decayed, is as acceptable as one closely attended by the incubating bird. From the fact that in all cases where down or other cover material was at hand, the investigators made it a point to conceal the eggs carefully before leaving them, it is believed that the number of desertions caused by intrusion, followed by crow attack, was small. The writer is convinced that, when the incubating bird is not actually flushed in the presence of crows, or when its eggs are well covered and the nest is left by the observer reasonably well concealed, his intrusion will not afford the crow an important clew as to nest site.

It cannot be emphasized too strongly, however, that careless intrusion of human beings into duck-nesting areas creates a hazard of utmost importance, for incubating ducks may then be flushed in the presence of crows and the suddenly uncovered eggs left exposed to view. It is for this reason that the breeding grounds of ducks should be carefully guarded against trespass during the nesting season.

#### PROBLEM OF THE CROW ON WATERFOWL BREEDING GROUNDS

Any attempt to appraise the role of the crow in its relation to nesting waterfowl throughout North America must take into consideration the distribution and abundance of the bird and the relationship of its range to that of the various species of waterfowl. Without this information a true and complete perspective of the crow as a predator on wild fowl cannot be obtained.

The crow (*Corvus brachyrhynchos*) is partial to areas devoted to agriculture and to a large extent is now dependent on them. In contrast with the raven (*C. corax*), which has receded with the advance of agriculture, the crow has extended its range in the north to the limits of such development. Beyond the northern border of agriculture, a line that conforms in general with the southern edge of the Canadian Life Zone, the crow is found in numbers only in the vicinity of settlements or clearings in which it can find a semblance of its typical environment. These spots are relatively few, widely scattered, and of limited area, compared with the enormous region extending northward to the Arctic Circle and beyond, in which much of the annual crop of ducks and geese of North America is produced.



The northern limit of the breeding (summer) range of the crow as shown by the heavy line on the accompanying maps (figs. 1-15) indicates the northern limit of the area in which it may be considered "common" to "abundant" and in which waterfowl, if present, might be subjected to undue pressure. The southern limit is something that can not be so clearly defined and about which there is less concern in the present discussion, since it extends below the southern edge of the productive breeding areas of most North American ducks. The area between these limits embraces the ranges of the various subspecific forms of the common crow (*Corvus brachyrhynchos*), including the more or less maritime northwest crow (*C. b. caurinus*), and the fish crow (*C. ossifragus*), which inhabits the South Atlantic coastal region.

Within the borders of the United States the crow-waterfowl problem involves the relationship of crows to a more dilute population of breeding ducks, scattered over an area somewhat greater than the overlapping ranges of these two groups in Canada. In this country there are extensive areas in which, because of the limited numbers of both crows and waterfowl, there is no crow-waterfowl problem of importance. This is true for much of the East and Southeast, with the exception of certain narrow coastal sections where the few resident ducks may encounter concentrations of fish crows. It also applies to extensive arid and mountainous sections in the West. As a matter of fact the crow-waterfowl problem of this country is restricted largely to the northern States of Minnesota, North Dakota, South Dakota, northern Nebraska, Montana, and sections of the coastal region in the Northwest. The crows of this region, together with those nesting in the Prairie Provinces immediately to the north and in parts of southern British Columbia, constitute the crow population most vitally affecting the welfare of the waterfowl of this continent.

In plotting the nesting areas of waterfowl on the maps, a distinction is made between the present "main breeding area" (indicated by darker cross hatching), much of which has been scarcely affected by the encroachment of civilization and, in recent years, drought; and the "area of reduced abundance" (shown by the horizontal lines), in which a number of factors have conspired to curtail the production of waterfowl. In each of the maps the range of the crow has been superimposed on the breeding ranges of the waterfowl. Consequently it is in the more heavily shaded areas within the limits of the crow's range that one may expect to encounter instances of acute conflict between crows and waterfowl. The explanation of the range maps of 15 common species (pp. 8 to 13) discuss briefly this territorial relationship.

#### EXPLANATION OF CROW-WATERFOWL RANGE MAPS

Of the six species of geese and brant commonly shot as game in the United States, only the Canada goose (*Branta canadensis*) finds the crow a nesting hazard (fig. 1). During recent years, when drought severely curtailed waterfowl nesting in the Northern States,<sup>4</sup> the

effect of the crow was restricted to a negligible part of the total population of Canada geese. Even during earlier years the Canada goose appeared well able to defend its nest against crow attack.

Of the commoner ducks, the wood duck (*Aix sponsa*), goldeneye (*Glaucionetta clangula*), bufflehead (*Charitonetta albeola*), greater scaup (*Nyroca marila*), old squaw (*Clangula hyemalis*), harlequin duck (*Histrionicus histrionicus*), the scoters (*Melanitta* and *Oidemia*), eiders (*Polysticta*, *Somateria*, and *Arctonetta*), and many of the mergansers (*Mergus* and *Lophodytes*), by reason of their



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FIGURE 1.—Relation of areas of crow abundance to the breeding range of the Canada goose.

northerly breeding grounds or their modes of nesting, are largely safe from the depredations of the egg-stealing crow. The ranges of these and certain forms that live in the South or the Southwest have not been plotted in maps on pages 9 to 25. The remaining commonly shot ducks, 14 species in all, have breeding ranges that are invaded to a greater or less extent by the crow.

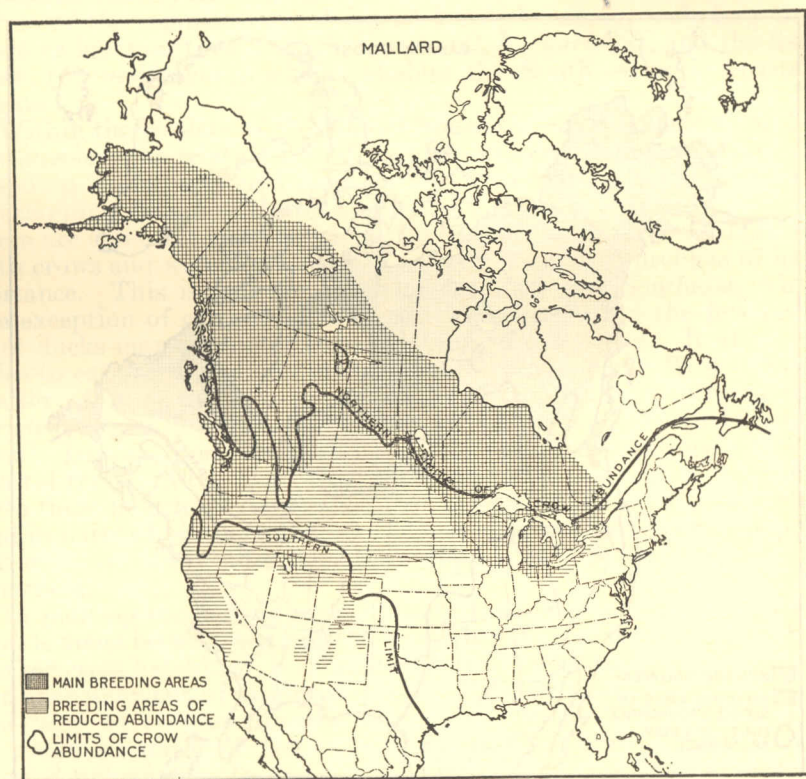
The mallard (*Anas platyrhynchos*), still abundant in the Middle West, nests as far north as the southern half of Alaska, including the Alaska Peninsula, and eastward to the southern shores of Hudson Bay and western Quebec. It encounters the crow in greatest numbers in the northern tier of States from Wisconsin to Montana and in the

<sup>4</sup> BELL, W. B., and PREBLE, E. A. STATUS OF WATERFOWL IN 1934. U. S. Dept. Agr. Misc. Pub. 210, 18 pp., illus. 1934.



southern parts of the Prairie Provinces and southwestern British Columbia (fig. 2). Possibly a fourth of the present productive breeding range of the mallard is today inhabited by the crow in what might be called destructive numbers. The eastern relative of the mallard, the black duck (*A. rubripes*), encounters a crow population of moderate density in the southern third of its breeding range (fig. 3).

The pintail (*Dafila acuta*), with a breeding range that includes all of Alaska and western Canada north to the Arctic Ocean and east to



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FIGURE 2.—Relation of areas of crow abundance to the breeding range of the mallard.

Hudson Bay, contends with destructive numbers of crows from Minnesota to the western edge of the Plains and north to the borders of agriculture in the Prairie Provinces, as well as in part of southern British Columbia, an area that includes less than a sixth of the pintail's productive breeding range (fig. 4).

Of the three teals, the cinnamon (*Querquedula cyanoptera*), nesting largely west of the one-hundredth meridian, encounters the crow in greatest numbers in southern British Columbia (fig. 5). The green-winged teal (*Nettion carolinense*), with a breeding range of irregular shape, extending with breaks to Bering Sea and the mouth of the Mackenzie River, encounters the crow in abundance in Montana, the Dakotas, and the southern part of the Prairie Provinces.

Possibly a fifth of the region in which this teal is today an abundant breeder is included in the region of crow abundance (fig. 6). The blue-winged teal (*Q. discors*), with its less extensive northern distribution, has more than half of its present productive breeding range within the area of great or moderate crow population (fig. 7).

The shoveler (*Spatula clypeata*), despite an irregular distribution that extends far to the northwest, has the crow to contend with over an area equal to about a third of its present range of abundance (fig. 8).



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FIGURE 3.—Relation of areas of crow abundance to the breeding range of the black duck.

Much of the present-day breeding range of the baldpate, or American wigeon (*Mareca americana*), lies north of the area of crow abundance (fig. 9). The remnants of the gadwall (*Chaulelasmus streperus*) population, more southerly in its distribution, are subject to crow pressure along our northern border and in the southern part of the Prairie Provinces (fig. 10).

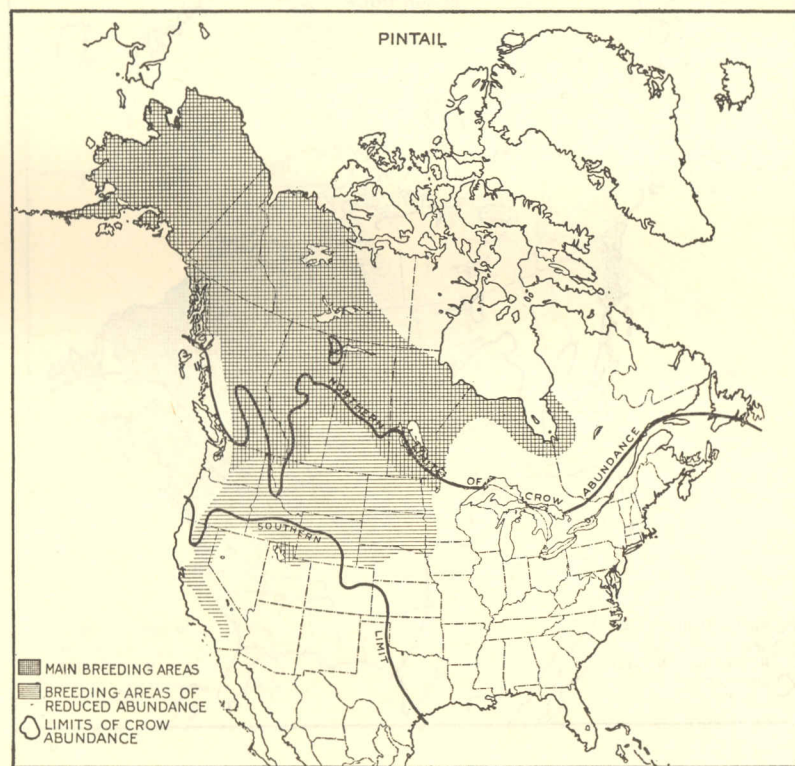
Of the diving ducks, the redhead (*Nyroca americana*), with its breeding range divided and much reduced in extent, is in most acute contact with crows in the southern part of the Prairie Provinces and in British Columbia (fig. 11), a state of affairs that applies also to the canvasback (*N. valisineria*) (fig. 12). The lesser scaup (*N. affinis*), because of its northern distribution and late nesting, as a



race is not seriously affected by the egg-stealing crow (fig. 13). The ring-necked duck (*N. collaris*) is threatened with crow aggressions over much of its breeding range, possibly more than half its total population being affected thereby (fig. 14).

Although originally the range of the ruddy duck (*Erismatura jamaicensis*) included a large crow-infested area, much of the remaining stronghold of this species lies north of the crow danger zone (fig. 15).

On the basis of the distribution of breeding duck populations in North America today, the species that appear to be in greatest jeop-



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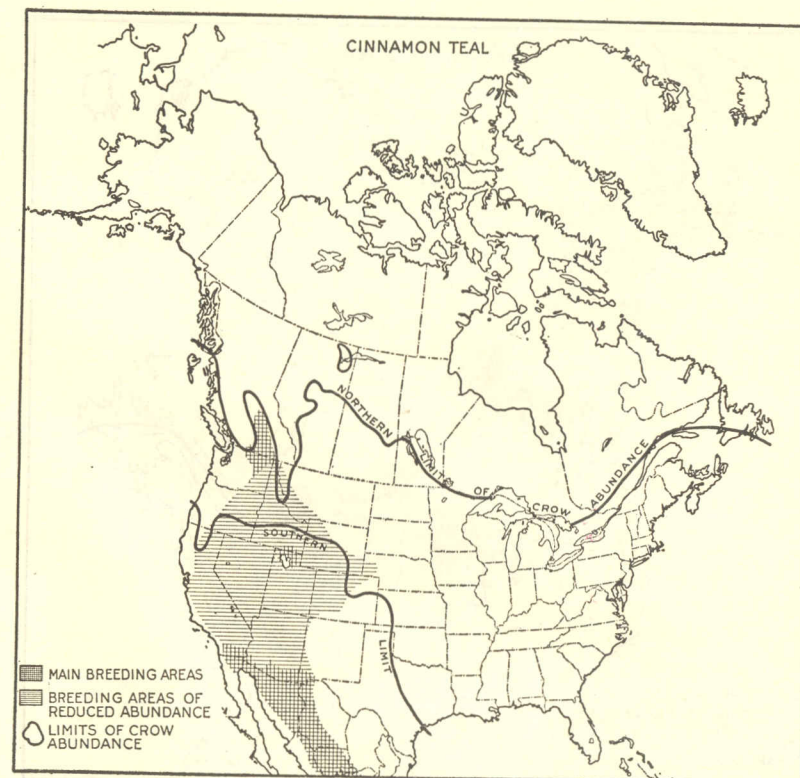
FIGURE 4.—Relation of areas of crow abundance to the breeding range of the pintail.

ardly from crow depredations are the gadwall and the blue-winged teal. This study also has shown that these two species are particularly vulnerable to crow attack (p. 19). Twelve other common species of ducks, including both deep- and shallow-water forms, are exposed to crow pressure in varying degrees.

It would be difficult to summarize merely in a brief and generalized manner the territorial relationship of crows to the entire North American wild-fowl population, but the statement may be made that not more than a sixth of the area occupied by breeding ducks and geese north of our border is also inhabited by an abundant and potentially destructive crow population. Within the United States proper a crow population, varying in density, may be found on most

of the wild-fowl breeding grounds, with the exception of those in the Great Basin and the Southwest.

In considering the relationships between the crow and the waterfowl in North America as a whole it is to be remembered that in the Northern States and in the southern part of the Canadian Provinces, agricultural development in the past half century has materially thinned the density of breeding wild-fowl populations. Although crows are abundant up to the very edge of agriculture, the number of breeding ducks inhabiting this southerly region is less than formerly, and the density of these populations is generally



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FIGURE 5.—Relation of areas of crow abundance to the breeding range of the cinnamon teal.

considered less than those to the north that breed outside of the range of the crow, agricultural lands, and the drought regions of recent years. Should the efforts now being made to rehabilitate waterfowl in this country result in these birds again becoming abundant in the North Central States, however, the matter of crow pressure on these duck-nesting grounds will become correspondingly more important.

#### CROW ABUNDANCE

Although no detailed census was made of the breeding crows in the areas studied, it is evident that, both in the vicinity of Water-



hen Lake and in the Cooking Lake section there is a greater population of breeding crows than in any region visited by the writer within the borders of the United States. Such a concentration extends up to the very limit of extensively cultivated land. In the pot-hole district about Prince Albert there is a marked diminution in the crow population, and as one travels north from that point into the more heavily wooded Canadian Life Zone, the birds immediately become scarce. Such a condition prevails everywhere beyond the limits of extensive agriculture, and it is only in the vicinity of settlements or clearings that crows are to be found in numbers.

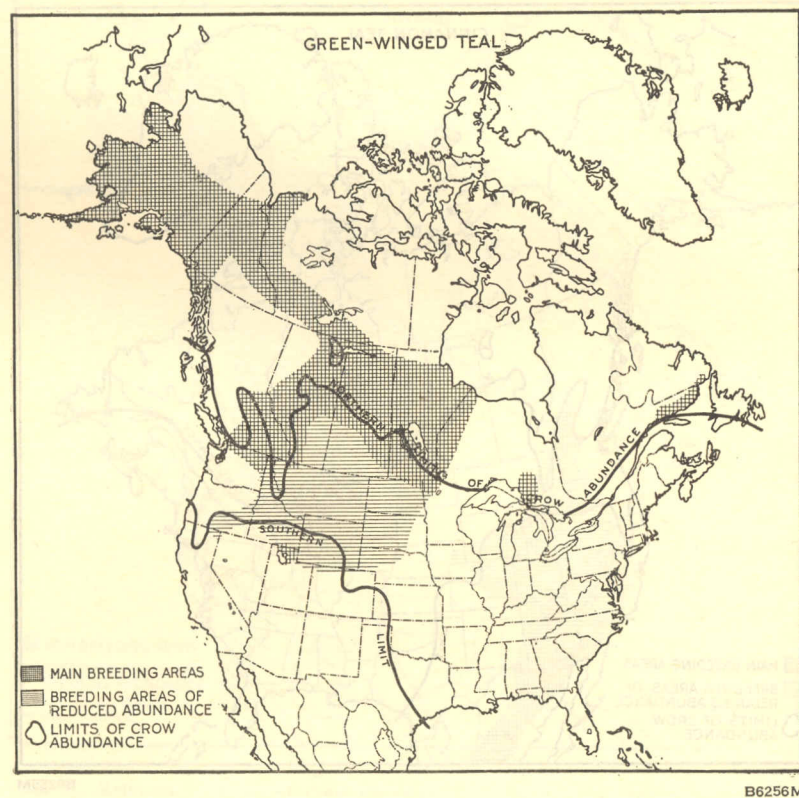


FIGURE 6.—Relation of areas of crow abundance to the breeding range of the green-winged teal.

In 1934 the number of crows nesting in the wooded area facing directly on Waterhen Lake (7 miles long and 1 to 2½ miles wide) was estimated to be in excess of 50 pairs. Although only part of these became confirmed egg stealers, yet these were to blame for the destruction of a large number of nests. An appraisal made on the basis of general impressions of abundance at Waterhen Lake placed the ratio of egg-stealing crows to duck nests at about 1 to 20.

On the islands in Ministik Lake crows were relatively even more abundant, and the presence of their nests close to duck-breeding areas

made the situation appear even more precarious for the waterfowl (pl. 1, B). Ministik Lake is essentially a scaup lake and, had it not been for the evasion of crow attack by this species through its late nesting, losses due to depredations by the large crow population would have been much more serious.

#### NEST OBSERVATIONS AND ANALYSIS OF RESULTS

Of the 601 duck nests observed during the 2 years' field work, histories were completed on 512. In each of the remaining 89 cases,

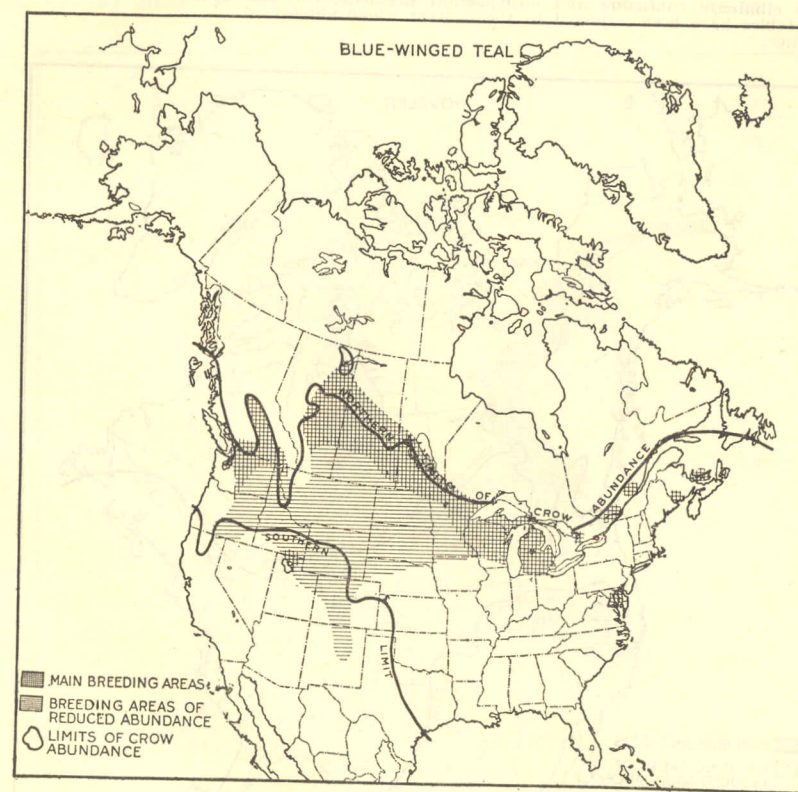


FIGURE 7.—Relation of areas of crow abundance to the breeding range of the blue-winged teal.

the nest was either lost in the course of the studies (14) or its history incomplete at the time the observations were terminated (75). Of the 512 completed nest histories, 288 were recorded in Saskatchewan (207 at or in the vicinity of Waterhen Lake and 81 in the Prince Albert section), and 224 in Alberta (Cooking Lake area). All of the latter were recorded in 1935, while of the 288 studied in Saskatchewan, 211 were observed in 1934 and 77 in 1935. The varied and pertinent information obtained is presented in tabular form so far as possible and developed and explained in the text.

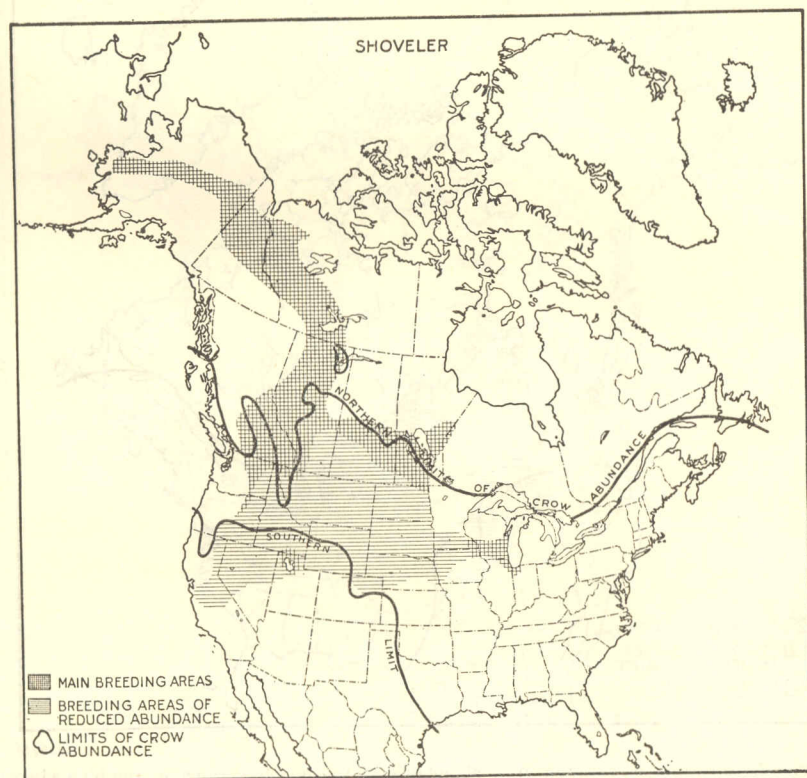


TABLE 1.—Outcome of 512 waterfowl nests recorded in Saskatchewan and Alberta, Canada, in the breeding seasons of 1934 and 1935

Item no.	Outcome	Number	Percent <sup>1</sup>	Item no.	Outcome	Number	Percent <sup>1</sup>
1	Hatched (some with reduced broods)	250	49	5	Female killed by predator	9	2
2	Destroyed by crows	156	31	6	Destroyed by trampling of sheep	1	(2)
3	Destroyed by unknown cause	53	10	7	Destroyed by fire	1	(2)
4	Deserted	40	8	8	Eggs taken by collector	1	(2)
				9	Infertile eggs	1	(2)

<sup>1</sup>To eliminate confusing and unimportant decimals, the percentages in this and all other tables have been adjusted to the nearest whole number.

<sup>2</sup>Trace.



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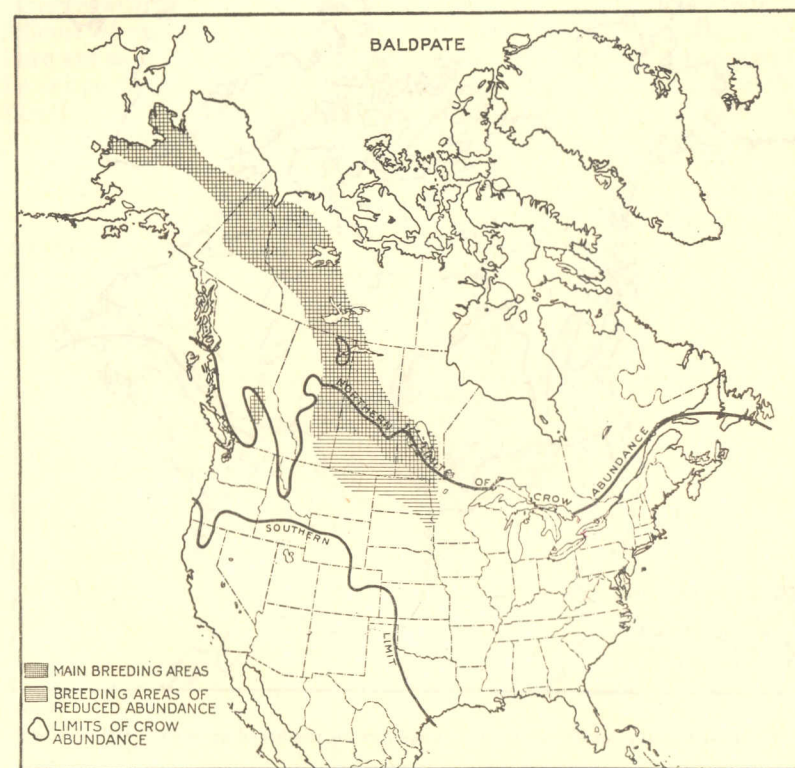
FIGURE 8.—Relation of areas of crow abundance to the breeding range of the shoveler.

## FATE OF THE 512 NESTS

In analyzing the data presented in table 1, it is necessary to consider in conjunction items 1, 2, and 3, which include nine-tenths of the recorded nests, since the line of demarcation between them is in some cases obscure. The hatched nests include all in which the incubating bird succeeded in bringing off at least one young. In some of these a loss of one or more eggs during the period of incubation was due to crow depredations or to other outside factors. In two

instances as many as five eggs were removed—one faithful pintail producing only two ducklings after having started with a set of seven eggs. Consequently, in appraising the hatch from these 250 nests, the actual output was something less than 100 percent. Of the total of 2,147 fertile eggs laid, 73, or 3.4 percent, were pilfered or destroyed during either the laying or the incubating period. Crows, manifestly, had played some part in this destruction.

Item 2, "destroyed by crows", is reasonably accurate and may be taken at its stated value. Egg destruction was not charged against the crow in any case where definite evidence of crow work was lacking, yet some of the nests recorded "destroyed by unknown cause" (item 3) may in fact have been robbed by crows. On the other



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FIGURE 9.—Relation of areas of crow abundance to the breeding range of the baldpate, or American wigeon.

hand, there is the possibility that, in the interval between visits of the observer, nests may have been deserted or the females killed, after which crows may have preyed on what were, in fact, abandoned eggs (item 4).

The nesting duck's attentiveness is looked upon generally as a great aid in the protection of the eggs against predators, particularly the crow. For this reason uncompleted and unguarded sets of eggs have been considered particularly vulnerable to crow attack. In this study, however, analysis of the status of the sets of eggs in the nests